

## REMARKS

### **Request for Rejoinder Reminder**

Applicants respectfully request rejoinder of method claims 17, 20-25, 27, 29-31, 33 and 35-38 upon allowance of the composition claims 1, 4-7, 9, 11-14, 39 and 40.<sup>1</sup> Towards that end, withdrawn method claims 17 and 30 have been amended in a manner consistent with the pending composition claims.

### **Rejection of Claims on Reference Grounds, and Traversal Thereof**

In the February 13, 2006 Office Action:

claims 1-7, 9, 11-12, and 14 were rejected under 35 U.S.C. §103(a) as being unpatentable over Vaartstra (U.S. Patent No. 6,149,828) in view of Mullee (U.S. Patent No. 6,306,564); and

claims 10-13 were rejected under 35 U.S.C. §103(a) as being unpatentable over Vaartstra in view of Mullee and further in view of Wilkinson et al. (U.S. Patent No. 5,789,505).

These rejections are traversed in application to the claims as amended herein. The patentable distinctions of the amended claims over the cited references are set out in the ensuing discussion.

### **Rejections under 35 U.S.C. §103(a)**

1. In the February 13, 2006 Office Action, claims 1-7, 9, 11-12, and 14 were rejected under 35 U.S.C. §103(a) as being unpatentable over Vaartstra (U.S. Patent No. 6,149,828) in view of Mullee (U.S. Patent No. 6,306,564). Applicants traverse such rejection.

Mullee relates to the removal of a resist, its residue and/or an organic contaminant using a supercritical CO<sub>2</sub> composition including a stripping chemical and/or an organic solvent. The

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<sup>1</sup> Rejoinder was previously requested in the response to the June 9, 2005 Office Action, filed June 15, 2005, and the response to the August 24, 2005 Office Action, filed November 23, 2005.

stripping chemicals disclosed in Vaartstra include ammonium bifluoride.

Vaartstra relates to a method for etching an inorganic material of a substrate using a supercritical etching composition. Importantly, Vaartstra discloses two different etching composition embodiments, as referred hereinbelow as “embodiment 1” and “embodiment 2” (see Vaartstra, col. 3, line 44 through col. 4, line 20).

- In one embodiment, the supercritical etching composition and method of removing an inorganic material using the composition includes at least one supercritical component and at least one nonsupercritical component. Preferably, the supercritical component is selected from the group of ammonia (NH<sub>3</sub>), amines (NR<sub>3</sub>), alcohols (ROH), water (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), inert gases (e.g., He, Ne, Ar), hydrogen halides (e.g., hydrofluoric acid (HF), hydrochloric acid (HCl), hydrobromic acid (HBr)), boron trichloride (BCl<sub>3</sub>), chlorine (Cl<sub>2</sub>), fluorine (F<sub>2</sub>), hydrocarbons (e.g., dimethyl carbonate (CO(OCH<sub>3</sub>)<sub>2</sub>), methane (CH<sub>4</sub>), ethane (C<sub>2</sub>H<sub>6</sub>), propane (C<sub>3</sub>H<sub>8</sub>), etc.), fluorocarbons (e.g., CF<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, CH<sub>3</sub>F, etc.), hexafluoroacetylacetone (C<sub>5</sub>H<sub>2</sub>F<sub>6</sub>O<sub>2</sub>), and combinations thereof. These compounds may be capable of etching without an additional component, depending on the material being etched. If, however, they are not capable of etching in and of themselves, a nonsupercritical component that is capable of etching (i.e., a nonsupercritical etching component) is used. Preferably, the nonsupercritical etching component is selected from the group of ammonia (NH<sub>3</sub>), hydrofluoric acid (HF), phosphoric acid (H<sub>3</sub>PO<sub>4</sub>), nitric acid (HNO<sub>3</sub>), acetic acid (CH<sub>3</sub>COOH), hydrochloric acid (HCl), sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), nitrogen trifluoride (NF<sub>3</sub>), sulfur hexafluoride (SF<sub>6</sub>), ozone (O<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), sulfur trioxide (SO<sub>3</sub>), amines (NR<sub>3</sub>), ammonium salts, hexafluoroacetylacetone (C<sub>5</sub>H<sub>2</sub>F<sub>6</sub>O<sub>2</sub>), and combinations thereof.
- 5 In another embodiment, the supercritical etching composition and method of removing an inorganic material using the composition includes a supercritical component that is capable of etching the desired inorganic material in and of itself. Preferably, for such embodiments, the supercritical component is selected from the group of ammonia (NH<sub>3</sub>), hydrofluoric acid (HF), acetic acid (CH<sub>3</sub>COOH), nitrous oxide (N<sub>2</sub>O), nitrogen trifluoride (NF<sub>3</sub>), hydrochloric acid (HCl), hydrobromic acid (HBr), water (H<sub>2</sub>O), and combinations thereof. In any of these embodiments, the supercritical etching composition can include a component selected from the group of oxidizers, buffering agents, surfactants, selectivity enhancers, and ligands. These components may be in the supercritical or nonsupercritical state. Thus, they may be present in the supercritical etching composition as supercritical components or nonsupercritical components.
- embodiment 1
- embodiment 2

It can be seen that embodiment 1 of the Vaartstra etching composition includes at least one supercritical fluid component (such as CO<sub>2</sub> and other solvents, e.g., alcohol) and at least one nonsupercritical fluid etching component. Embodiment 2 of the Vaartstra etching composition includes a supercritical component that is capable of etching in and of itself and can further

include surfactants. Conspicuously, surfactants are not a listed component of embodiment 1, which may include CO<sub>2</sub> and other solvents *and* CO<sub>2</sub> is not a listed component of embodiment 2 which may include surfactants.

According to the Examiner, Vaartstra teaches a supercritical etching composition that includes alcohols, carbon dioxide, etching components such as HF, and surfactants, and Mullee teaches a composition including CO<sub>2</sub>, one or more chemicals such as ammonium bifluoride, and an organic solvent such as an alcohol. As such,

“[i]t would have been obvious to one having ordinary skill in the art at the time of the claimed invention to modify Vaartstra’s composition by employing alcohols as specified by [sic] and ammonium bifluoride as taught by Mullee because using ammonium bifluoride along with organic and/or inorganic stripping solvent(s) supported by supercritical CO<sub>2</sub> is known to effect the removal of contaminants from a wafer surface (Mullee, column 1, lines 9-14).” (see February 13, 2006 Office Action, page 4, lines 12-17)

Applicants vigorously disagree.

It is well established in the art that prior art references must be considered as a whole. *W.L. Gore & Associates, Inc., v. Garlock, Inc.*, 220 U.S.P.Q. 303 (Fed. Cir. 1993), *cert. denied*, 469 U.S. 851 (1984).

As introduced hereinabove, the teaching of Vaartstra is clear and unambiguous: embodiment 1 relates to a supercritical composition which may include CO<sub>2</sub> and solvents such as alcohol and does not recite that surfactants may be added to said embodiment. Similarly, embodiment 2 relates to a supercritical composition which may include surfactants and does not recite that CO<sub>2</sub> may be added to said embodiment. In other words, contrary to the Examiner’s contention, considering Vaartstra as a whole, Vaartstra does not motivate, teach or suggest a supercritical etching composition including solvents, CO<sub>2</sub> and surfactants, but rather one embodiment that can include CO<sub>2</sub> and other solvents such as alcohol and another embodiment that can include surfactants. There is absolutely no motivation, teaching or suggestion in Vaartstra that the components of the two different compositional embodiments are interchangeable or should be combined in a manner other than that disclosed.

The Examiner has indicated that it would be obvious to combine Vaartstra with Mullee. Knowing that there are two different compositional embodiments disclosed in Vaartstra, applicants question which one the Examiner proposes should be combined with Mullee? The combination of Mullee with embodiment 1 at best discloses a composition that may include CO<sub>2</sub>, other solvents such as alcohol, and ammonium bifluoride **but not surfactants**, while the combination of Mullee with embodiment 2 at best discloses a composition that may include surfactants and ammonium bifluoride **but not CO<sub>2</sub>**.<sup>2</sup>

In short, contrary to the Examiner's contentions, the combination of Vaartstra and Mullee does not motivate, teach or suggest each and every limitation of applicants' claimed invention. Accordingly, one of the requirements needed to establish a *prima facie* case of obviousness has not been met. See, *In re Royka*, 180 USPQ 580 (CCPA 1974).

If the Examiner disagrees with applicants' assessment of the teaching of Vaartstra, the Examiner is respectfully reminded that the areas of the Vaartstra reference that suggest the modification that the surfactants of embodiment 2 may be combined with the CO<sub>2</sub> and the other solvents of embodiment 1 must be explained with specificity. See, *Ex parte Humphreys*, 24 U.S.P.Q.2d 1255, 1262 (B.P.A.I. 1992). The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. *In re Fritch*, 23 U.S.P.Q.2d 1780, 1783-84 (Fed. Cir. 1992).

In addition, it is noted that Mullee and Vaartstra relate to the removal of entirely different materials from the surface of a semiconductor substrate - Mullee discloses the removal of photoresist, its residue and/or organic contaminants from the substrate while Vaartstra discloses

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<sup>2</sup> It is further noted that Vaartstra does not provide any guidance to specifically selecting the CO<sub>2</sub> and alcohol for embodiment 1 from the extensive list of possible ingredients, or surfactants for embodiment 2 from the extensive list of possible ingredients. Similarly, Mullee does not provide any guidance to specifically selecting CO<sub>2</sub>, alcohol co-solvent and ammonium bifluoride from the extensive list of possible ingredients. Selection of and combining ingredients arbitrarily is not obvious because of the underlying problems of compatibility, stability and pharmacologic actions of the ingredients which one skilled in the art needs to ascertain before coming up with the inventive composition. Obvious to try is an improper criterion.

the etching of inorganic material from the substrate. Importantly, Vaartstra teaches away<sup>3</sup> from the combination of Vaartstra and Mullee by expressly reciting that the Vaartstra composition is to be used to etch various inorganic films, specifically inorganic films which are not covered by a patterned resist mask layer (see Vaartstra, col. 1, lines 29-34), i.e., inorganic materials that are exposed following the development of the photoresist material, and that the Vaartstra composition can be tailored to “etch exposed material beneath a patterned photoresist layer, without simultaneously etching the photoresist layer” (see Vaartstra, col. 6, lines 17-20). In short, Vaartstra does not desire that the remaining photoresist mask layer be removed by the etching composition. Clearly, there can be no motivation, teaching or suggestion to combine two references that teach two mutually exclusive end results.

In conclusion, Vaartstra teaches away from the combination of Vaartstra and Mullee and said combination does not motivate, teach or suggest each and every limitation of applicants’ claimed invention. Withdrawal of the rejection of claims 1-7, 9, 11-12, and 14 under §103 in view of Vaartstra and Mullee is respectfully requested.

2. In the February 13, 2006 Office Action, claims 10-13 were rejected under 35 U.S.C. §103(a) as being unpatentable over Vaartstra in view of Mullee and further in view of Wilkinson et al. (U.S. Patent No. 5,789,505) (hereinafter Wilkinson). Applicants traverse such rejection.

It is initially noted that claim 10 was cancelled in the response to the August 24, 2005 Office Action as filed on November 23, 2005. As such, the rejection of claim 10 herein is moot.

Wilkinson relates to the use of surfactants in applications using liquid/supercritical CO<sub>2</sub>.

As discussed hereinabove, the combination of Vaartstra and Mullee does not make obvious applicants’ claimed invention. The inclusion of Wilkinson does not cure this deficiency. In fact, Wilkinson has been cited merely to modify the surfactant disclosed in Vaartstra. As such, applicants’ claimed invention remains non-obvious in view of Vaartstra, Mullee and Wilkinson.

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<sup>3</sup> The Examiner is respectfully reminded that it is improper to combine references where the references teach away from their combination. See, e.g., *In re Grasselli*, 218 U.S.P.Q. 769, 779 (Fed. Cir. 1983).

It is noted that the Examiner indicated on page 6 of the February 13, 2006 Office Action that “Vaartstra in view of Mullee and Wilkinson illustrate the specific combination of a supercritical fluid, co-solvent, an etchant (bifluoride compound) species, and one surfactant in a composition is known.” As discussed hereinabove, the combination of Vaartstra, Mullee and Wilkinson does not make obvious applicants’ claimed invention including  $\text{SCCO}_2$ , at least one co-solvent, at least one bifluoride, and at least one surfactant.

Accordingly, applicants respectfully request withdrawal of the rejection of claims 11-13 under §103 in view of Vaartstra, Mullee and Wilkinson.

### **New Claim 39**

New claim 39 recites:

**“A sacrificial silicon-containing layer etching composition consisting essentially of supercritical  $\text{CO}_2$  ( $\text{SCCO}_2$ ), at least one co-solvent, and at least one bifluoride compound selected from the group consisting of ammonium bifluoride and tetraalkylammonium bifluoride  $((\text{R})_4\text{NHF}_2)$ , wherein R is methyl, ethyl, butyl, phenyl or fluorinated  $\text{C}_1\text{-C}_4$  alkyl groups.”**

Support for new claim 39 can be found in original claims 1, 3 and 8 and paragraph [0027].

No new matter has been added herein.

### **Fees Payable**

Four (4) dependent claims have been cancelled and two (2) independent claims have been added herein. Notably, the addition of two (2) independent claims brings the total number of independent claims to four (4), three (3) of which are included in the price of the original filing. Accordingly, a claims fee of \$100.00 is due herein  $((2 \times \$50) + (1 \times \$200.00)) - (4 \times \$50.00) = \$100.00$


A check to the Commissioner of Patents in the amount of \$100.00 is enclosed herewith. The Commissioner is also authorized to withdraw any deficiencies from, or credit any overpayments to, **Deposit Account No. 13-4365** in the name of Moore & Van Allen, PLLC.

**Conclusion**

Based on the foregoing, claims 1, 4-7, 9, 11-14, 39 and 40 are in form and condition for allowance. If any additional issues remain, the Examiner is requested to contact the undersigned attorney at (919) 286-8000 to discuss same.

Respectfully submitted

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